Energy of the $3/2^+$ state of ^{229}Th revisited

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The unusually low energy of the $3/2^+$ isomeric state of ^{229}Th makes this an interesting nucleus to study the interaction between atomic and nuclear degrees of freedom. The adopted excitation energy, Δ=3.5(10) eV, was determined from some assumptions related to the level scheme and gamma-ray transitions in ^{229}Th and a careful investigation of the gamma-ray energies [1]. Recently, [2,3] two different hypotheses related to the 29 keV, 71 keV, and 146 keV transitions in ^{229}Th were suggested.

In this work we investigated the consequences of those hypotheses using the experimental information quoted in refs. [1,4], the statistical procedure of ref. [5], and gamma-ray standards from [6]. In a first step we adopted the common hypotheses of refs. [1-3,7] and determine the energies of the three transitions above and of the ^{229}Th levels.

In a second step we tested the two hypotheses. Supposing that the 146 keV feeds the g.s. and the 29 keV and the 71 keV feed the $3/2^+$ level [2], we obtained Δ=2.3(10) eV with P(χ^2)Assuming that the 146 keV feeds the $3/2^+$ level and that both the 29 keV and the 71 keV transitions feed partially the $3/2^+$ level (with relative intensities of 75% and 60%, respectively) and partially the g.s. [3], the result is Δ=5.9(10) eV with P(χ^2)=33%.

The assumptions that the 29 keV and 71 keV feed both the $3/2^+$ and the g.s. agree well with the experimental data and affect the adopted value of Δ. Since the interaction between atomic and nuclear degrees of freedom depends strongly on Δ, these assumptions must be carefully investigated.

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